ADAPTIVE CHROMA DOWNSAMPLING AND COLOR SPACE CONVERSION TECHNIQUES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims benefit under 35 U.S.C. § 119(e) of Provisional U.S. patent application No. 62/131,052 filed on Mar. 10, 2015, the contents of which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] This application relates to digital image processing techniques.

[0003] The present invention relates to video coding techniques. Video distribution systems include a video source and at least one receiving device. The video content may be distributed over a network or over fixed media. To keep complexity and cost low, video content is typically limited in dynamic range, e.g., 8-10 bit signal representations and 4:2:0 color format. Recent advances in display technology, however, have opened the door for the use of more sophisticated content (also referred to as higher quality content), including content characterized as High Dynamic Range (HDR) and/or wide color gamut (WCG), as well as content with increased spatial and/or temporal resolution. This higher quality content is typically converted to a lower range using a Transfer Function (TF) that is followed by a quantization to a particular fixed bit-depth precision (e.g. 8 or 10 bits). The conversion may also include a color space conversion process, in a space that may be friendlier for encoding, as well as color format conversion, e.g. converting data from 4:4:4 or 4:2:2 to a representation with fewer chroma samples (e.g. 4:2:2 and 4:2:0), before encoding for distribution using a video compression system. These steps can introduce banding and other artifacts that may impact and substantially degrade the quality of the video content when decoded and displayed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Embodiments of the present disclosure will be described more fully hereinafter with reference to the accompanying drawings, in which:

[0005] FIG. **1** is a block diagram of an example of a video communication system.

[0006] FIG. **2** is a block diagram of an example video coding engine.

[0007] FIG. **3** is a block diagram of an example color format conversion for encoding.

[0008] FIG. **4** is a flowchart for an example process for choosing a downsample filter.

[0009] FIG. **5** is a flowchart for an example process for a pixel-by-pixel selection of downsample filters.

[0010] FIG. **6** is a flowchart for an example process for selecting a downsample filter.

[0011] FIG. **7** is an example dataflow diagram for converting R'G'B' to Y'CrCb.

[0012] FIG. **8** is an example dataflow diagram for converting R'G'B' to YCrCb.

DETAILED DESCRIPTION

[0013] A method, system and computer readable medium are described for converting digital images with adaptive chroma downsampling. The method comprises: converting image content from a source color format to a second color format; for a plurality of candidate downsample filters, filtering converted image content according to the respective downsample filter, filtering the downsample-filtered content according to an upsample filter, and estimating a distortion corresponding to the respective filter from the upsample-filtered content; and generating output image content according to a downsample filter selected according to the estimated distortions.

[0014] An additional method system and computer readable medium are described for converting from a source color format to a second color format including: converting the image content from R, G, and B signals of the RGB format into a luma signal; quantizing the luma signal; reconstructing the luma signal by inverse quantization of the quantized luma signal; converting the reconstructed luma signal and the R signal into a Cr signal; and converting the reconstructed luma signal and the B signal into a Cb signal.

[0015] Video and image compression systems often operate in a color space/representation different than the capture color space/representation and/or display color space/representation. For example, video may be captured in an RGB color space but will be translated to a YCbCr color space. This is done to maximize the compression properties of the video signal, by essentially exploiting redundancies and moving into color spaces that may have better compression, homogeneity, and error masking properties.

[0016] Commonly, decoders and receivers conventionally have a limited or known number of filters, including those implemented for upsampling the decoded data to fit a particular display. However, transmitters, which may include a color format converter, pre-processor, and encoder, conventionally optimize filter selection, including downsampling filters, without consideration for the target device or devices. Accordingly, improved techniques for transmitter and receiver filter selection and color space conversion are provided herein, to be carried out in the image/video processing chain.

[0017] Therefore, the inventors perceived a need in the art for improved encoding processes, and in some instances matching improved decoding processes. These improved processes may be capable of handling higher quality content and taking into consideration the captured content and the anticipated decoding operations that results in an improved experience (such as less visual distortion) at the output of a decoder, as compared to using conventional encoders.

[0018] FIG. **1** is a block diagram of an example of a video communication system. Source video **102** is transmitted by a receiver **120** through a communications channel **110** to a receiver **122** to be output as recovered video **118**. Transmitter **120** may comprise a pre-processor **104** that outputs pre-processed video data to coding engine **108**. A controller **106** may manage pre-processing and encoding operations where applicable. After transmission through communications channel **110**, receiver **122** may recover and decode the received encoded video at decoder **112**. The post-processing may be applied to the decoded video at post-processor **116**. A controller **114** may manage decoding and post-processing where applicable. In embodiments where the post-processing is not fixed, pre-process parameters selected by the pre-processor **104** can be included as side information in the encoded bitstream transmitted over channel **110**. Then at the